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GRAINS CHARGES IN INTERSTELLAR CLOUDS

N. Bel, J.P. Lafon, Y.P. Viala
Observatoire de Paris-Meudon
92195 Meudon Principal Cedex, France

The charge of cosmic grains is a parameter which could play an important role in many astrophysical phenomena. It probably has an influence on the coagulation of grains and more generally on grain-grain collisions, and on the interaction between charged particles and grains which could lead to the formation of large grains or large molecules. It is of deciding importance when the interaction with cosmic magnetic field is taken into consideration, both in quiet or perturbed media. For example, the dynamics of the grains, through the action of the magnetic field on the particle trajectories, could be completely perturbed in interstellar shocks. Moreover, the coupling between neutral and ionised matter controls the drift of the magnetic field across "normal" interstellar clouds: this process could be influenced by grains, if the charge were sufficiently large, with well known effects on protostar formation processes.

The electrostatic charge of grains depends mainly on the nature of the constitutive material of the grain and on the physical properties of its environment: it results from a delicate balance between the plasma particle collection and the photoelectron emission, both of them depending on each other; the properties of the medium in which the grain is embedded have to be determined by modelling the cloud. Now, the charge of a grain is obtained in two steps: we compute the characteristics of the environment of the grain, i.e. the chemical structure of the cloud and the intensity of the radiation field at each stage of its propagation through the cloud; for this we use the numerical model developped by Clavel et al. (1978) and improved by Viala (1986). Then, we determine the charge of a grain which is

embedded in this environment by using the recent and general study of Lafon et al. (1981). This treatment is fully justified because the electrical equilibrium state of the cloud is not affected by the charge of the grains, since in interstellar clouds the ratio of the number density of grains to that of the gas is very low, of the order of 10^{-12}.

We have obtained (Bel et al. 1988) the profile of the equilibrium charge of some "typical" grains through different types of interstellar clouds (hot diffuse, moderately diffuse and dense cloud, with hydrogen number density spanning from 10 to 10^4 cm^{-3}) as a function of the depth of the cloud.

The grain charge can reach high values (up to 130 proton charges) in hot diffuse clouds. In such clouds, the charge is practically constant throughout the cloud; on the other hand, in clouds with higher densities ($\sim$ 100 cm^{-3}), it can also reach rather high values ($\sim$ 40) but it strongly depends on the position of the grain inside the cloud. The results are very sensitive to the mean UV interstellar radiation field (whose determinations could fairly differ from one author to another). Three parameters appear to be essential but with different levels of sensitivity of the charge: the gas density, the temperature and the total thickness of the cloud. In addition, the charge of grain is investigated in a model mimicking the physical conditions in the cloud in front of the particular star ζ Oph.

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